NASA TECHNICAL TRANSLATION NASA TT F-14,582

NTIS HC $3.00

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(NASA-TT-F-14582) SPECTROGRAMS OF ALPHA LYRAE AND BETA CENTAURI IN THE RANGE OF 2000-3800 ANGSTROMS (Translation Consultants, Ltd.) 8 p HC $3.00 CSCL 03A G3/30

N73-16831

Unclas 53845

Translation of "Spektrogrammy α Lyra i β Cen v oblasti 2000-3800 angstrem," Soobshcheniya byurakanskoy observatorii, Yerevan, No. 45, 1972, pp. 20-26.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 JANUARY 1973

NASA TT F-14,582

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ABSTRACT. When the orbital station "Salyut" was in flight six spectrograms of β Centauri (June 18, 1971) and nine spectrograms of α Lyrae (June 21, 1971) were obtained in the range of 2000-3800 Å. The spectrograms were received with the help of the observatory "Orion" installed on the external surface of the "Salyut" and remote-controlled by the cosmonaut from within. The spectrograms were obtained photographically on a film with spectral resolution of about 5 Å on 2600 Å. After completing the program of observations the cassette containing the film with the pictures was delivered to the earth where the spectrograms were developed. Laboratory standards essential for plotting the characteristic curve were taken on pieces of film returning from space. After two months' orbiting in outer space the latter proved to be quite fogged (the density of the background blackening was 0.8-0.9). Most of the spectrograms of α Lyrae and β Centauri obtained were overexposed. The paper carries specimens of microphotometric recordings of normal spectrograms. They indicate a number of absorption lines.

During flight of the "Salyut" orbital station, manned by cosmonauts G. T. Dobrovol'skiy, V. N. Volkov, and V. I. Patsayev, it was possible to obtain six spectrograms of β Centauri (18 June 1971) and nine spectrograms of α Lyrae (21 June 1971) in the wavelength range 2000-3800 Å and with a spectral resolution of about 5 Å at 2600 Å. /20*

The spectrograms were obtained using the "Orion" system, constituting a telescope of the Mersenne optical system with a clear diameter of the main mirror of 280 mm, operating in combination with a slitless spectrograph of the Wadsworth system (Figure 1). The use of a concave diffraction grating with a radius of curvature of 500 mm had a ruled part measuring 50 x 55 mm. The lines were drawn on an aluminum layer applied to a glass backing. The number of lines was 1,200 per 1 mm and the form of the lines was selected in such a way that it ensured a maximum concentration of radiation at about 2600 Å. Spectrograph dispersion was 32 Å/mm. With a relative aperture of 1:5 or with an equivalent

* Numbers in the margin indicate pagination in the foreign text.

focal length of the telescope with the spectrograph of 1,400 mm, the angular scale in the focal plane of the camera spectrograph was 2.5' per 1 mm. /21

The "Orion" spectrograph was designed for obtaining shortwave spectrograms of stars to 5^m with a half-hour exposure. The operating principle of the "Orion" as used by a cosmonaut and also a description of its design and electronic systems are given in [1-3]. Spectrograms were obtained photographically on punched film 16 mm wide covered by an emulsion of the UFSh-4 type [4].

Astronomical observations with the "Orion" system are made only in the shadow part of the orbit. Preparation for observations begins long before the orbital station enters the shadow part of the orbit. The preparations themselves involve primarily orienting the orbital station in the necessary position relative to the star sky. More definitely this means that at the time the station enters the earth's shadow the window in front of which the sighting tube for remote guidance of the "Orion" telescope stands should be directed, for example, toward the constellation Lyra, if on this particular orbital revolution plans call for obtaining a spectrogram of α Lyrae or some other near-lying star. Later everything occurs the same as was described in [1, 2]. By manipulating the switches with the keys, the sighting telescope is aimed at this star in such a way that it is at its center with an accuracy to ±0.5°. Approximately five to six seconds after this an electric indicating lamp on the spacecraft's "Orion" control panel lights up, warning that the star has been intercepted by the photographic guide (situated on the outside, on the telescope unit) and is being automatically oriented on its optical axis. At this time application of pressure on the control panel triggers a programming device which programs the entire desired cycle for obtaining spectrograms with different exposures.

The entire crew of the "Salyut" space station participated in obtaining spectrograms of α Lyrae and β Centauri. The tasks were distributed in the following way: commander G. T. Dobrovol'skiy controlled orientation of the station, striving to hold it in the necessary position relative to celestial coordinate systems; spacecraft engineer V. N. Volkov watched the on-board systems; and engineer-researcher V. I. Patsayev directly controlled operation of the "Orion" system through his sighting tube and control panel.

The spectrograms of α Lyrae and β Centauri were obtained with exposures from 10 seconds to 6 minutes. All the spectrograms were obtained with a broadening to 0.4 mm. However, in some cases, particularly during prolonged exposures, the broadening was two or three times greater than the computed value. According to preliminary data, this was caused by brief disorder (autooscillation) of one of the tracking system axes in the plane perpendicular /22 to the direction of spectrograph dispersion.

After fulfilling the observation program the magazine with the exposed photographic film was detached from the "Orion" apparatus and delivered within the "Salyut" through a small lock. Development and further processing of the film was accomplished under ground conditions after the cosmonauts delivered the film to earth in the descent module.

It is important to note that the spectrograms necessary for constructing a characteristic curve were obtained on pieces of the same photographic film which remained unused within the "Orion" magazine. Precisely for this purpose provision was made for rewinding of all the photographic film remaining in the primary magazine into the receiving magazine upon completion of the work. Standard spectrograms were obtained in the laboratory immediately after the film from the "Orion" was returned to the earth. This ensured total uniformity in physical parameters (degree of fogging, spectral sensitivity, contrast, etc.) of the basic and standard films.

This requirement, obtaining standard spectrograms (or photographs) on pieces of photographic film returned from space, must be regarded as necessary and important in such experiments, since as demonstrated in the "Orion" experiment, the fogging phenomenon is inevitable for films present in space. After a period of more than two months presence under exoatmospheric conditions the "Orion" film was highly fogged; the density of background blackening of the UFSh-4 film was about 0.8-0.9. The cause for fog formation is not entirely clear, but the role of the gamma radiation which could arise as a secondary product as a result of interaction of primary cosmic rays with matter is obvious.

The characteristic curves were constructed on the basis of laboratory spectrograms from a mercury lamp obtained through a stepped attenuator. Extrafocal images of individual spectral lines were used in the measurements. Several characteristic curves for individual sectors of wavelengths were used due to the clearly expressed dependence of the slope of the characteristic curve on wavelength during measurements of the principal spectrograms (Figure 2).

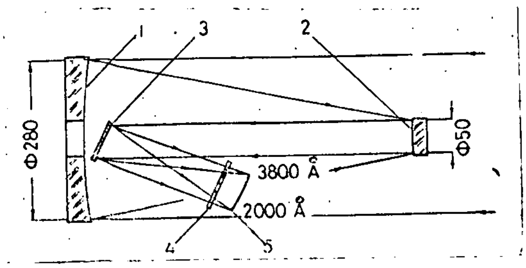

Figure 1. Optical diagram of "Orion" star telescope with spectrograph. 1 - large parabolic mirror; 2 - small parabolic mirror; 3 - diffraction grating; 4 - plane-parallel quartz plate; 5 - photographic film.

Even a fleeting glance at the developed tape reveals that unfortunately most of the spectrograms of α Lyrae (m_V = 0.14, spectral type AI V) and in particular β Centauri (m_V = 0.86, spectral type B3 II) were highly overexposed and therefore only their shortwave ends can be measured. However, there are spectrograms (although few in number) with a normal blackening density throughout the entire length. Figure 3 shows samples /23 of spectrograms of these stars and Figure 4 shows the microphotometric records of these spectrograms obtained using a MF-4 automatic microphotometer.

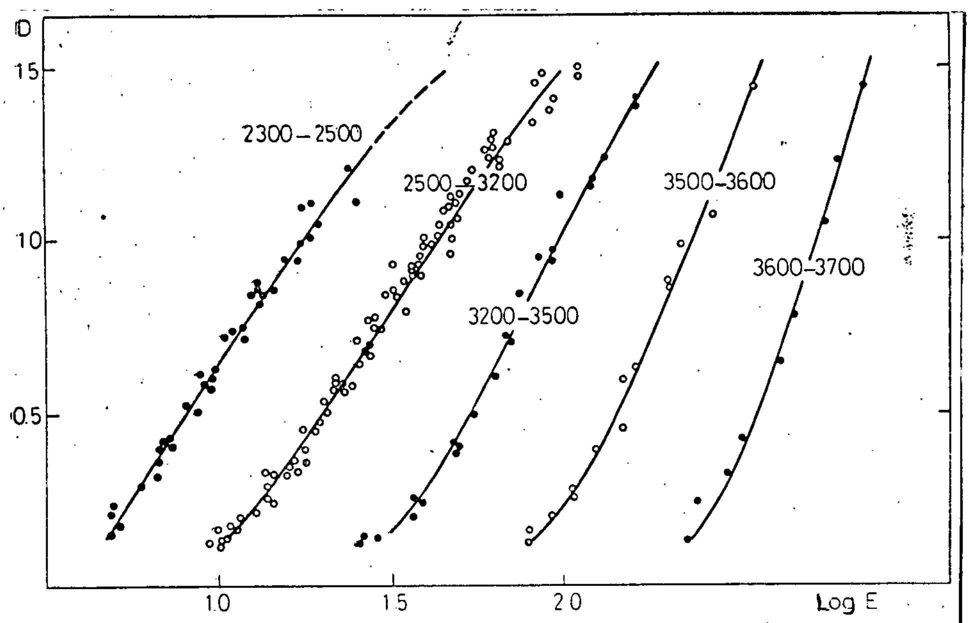

Figure 2. Characteristic curves of UFSh-4 photographic film remaining in space a long time.

The measurements and especially the observed energy distribution in the continuous spectrum of these stars in the region 2000-3800 Å will be given elsewhere. Here we will limit ourselves to general remarks. For example, on the spectrogram one can see the last absorption lines of the Balmer series of of hydrogen (running from H8, H9, etc.). The Balmer jump near 3650 Å is visible.

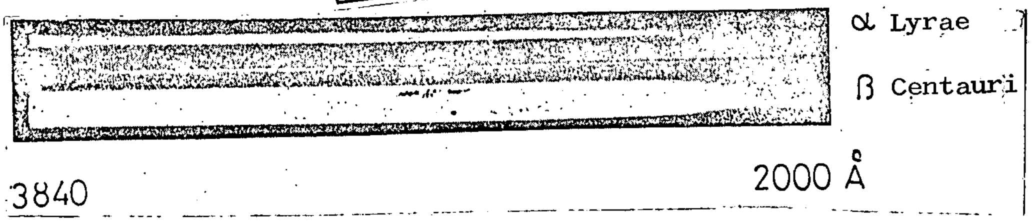

Figure 3. Samples of spectrograms of α Lyrae and β Centauri obtained using the "Orion" system in the wavelength region 2000–2800 Å.

On all spectrograms of α Lyrae one can clearly see a broad absorption line, the doublet of ionized magnesium (2796 MgII and 2803 MgII), near 2800 Å. /24
A relatively strong absorption line near 2500 Å and other weak lines in the direction of the shortwave end of the spectrogram also stand out rather clearly.

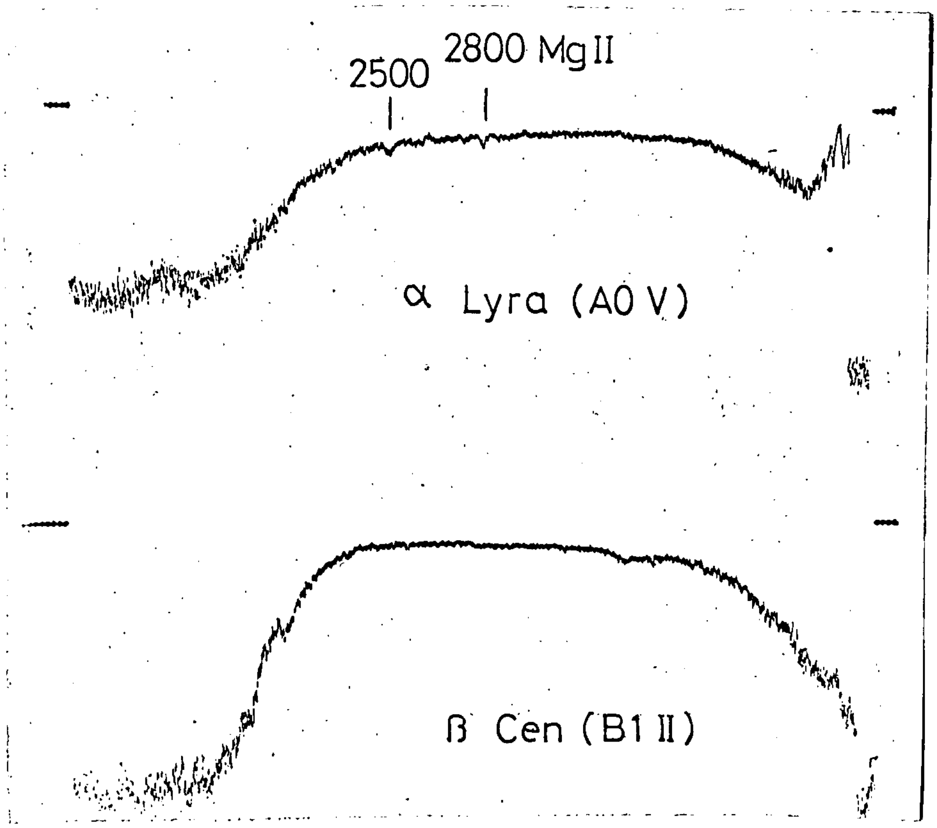

Figure 4. Microphotometric records of spectrograms of α Lyrae and β Centauri.

We express deep appreciation to A. Kasin and M. Krmoyan for assistance rendered in preparing the observation program.

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Byurakan Astrophysical Observatory and
the "Astro" Special Design Bureau

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Translated for the National Aeronautics and Space Administration under contract NASw-2038 by Translation Consultants, Ltd., 944 South Wakefield Street, Arlington, Virginia 22204.